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An Introduction to the
**LITERATURE OF
CHEMISTRY**

FOR SENIOR STUDENTS AND
RESEARCH CHEMISTS

BY

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FOREWORD

THOSE employed in supervising research are only too well aware of the difficulty in familiarizing students with the way chemical facts are catalogued and with the method which must be adopted in order to find out whether a substance is known or not and, if known, where an account of its preparation and properties is to be found.

It will be a relief to those in charge of the ever-increasing number of research students to be able to direct them to the clear introduction to the literature contained in the following pages, and Dr. Mason is to be congratulated on producing so valuable and convincing and at the same time so simple a work on this important aspect of the subject.

As far as I am aware, this is the first work of its kind to be published in this country, and there is every reason to suppose that it will prove a boon not only to those engaged in research but also to those who for other reasons wish to consult the literature.

W. H. PERKIN.

Dyson Perrins Laboratory,
Oxford.

AN INTRODUCTION TO THE LITERATURE OF CHEMISTRY

AN intimate knowledge of the literature of pure and applied chemistry, both of its resources and the best methods of making use of them, is essential for all those who have to deal with chemical problems, whether in the University, the Technical Research Laboratory, or the Works; and the following notes have been compiled to assist the beginner to find his way through a somewhat difficult region and to give him a general idea of the scope of the subject.

Not infrequently a chemist, having a new problem to investigate, fails through ignorance or carelessness to carry out an effective search of the literature; with the result that after months of hard work in the laboratory, he discovers that his work has already been done some time before in another laboratory.

It is most essential, therefore, before beginning a new piece of work, to find out exactly what is already known, so as to avoid waste of time.

For this purpose it is necessary to know, first, the nature and scope of the literature of chemistry, and secondly the best way to set about making a search. For this reason these notes are divided into two portions dealing respectively with

- (1) The actual literature,
- (2) Making a search.

A moderate knowledge of French and German, together with the ability to read original papers in these languages, is essential, whilst practice in reading both English and foreign scientific literature is of course the only satisfactory method of familiarizing oneself with chemical literature. The present notes do not pretend to do more than indicate the more important journals and books dealing with chemistry, but they may serve as sign-posts to the main avenues of approach.

As my chief purpose is to bring to notice the more important books of reference and introductory works to special branches of chemistry, it will be understood that many valuable educational works have necessarily been omitted.

FREDERICK A. MASON.

Oxford,

November 12, 1924.

PART I

The Literature

FOR convenience the subject will be divided up into the following sections:

- I. *General Dictionaries and Encyclopaedias.*
- II. *Chemical Journals and Periodicals.*
- III. *Abstract Journals.*
- IV. *Text-Books and Special Works of Reference:*
 - (a) Historical.
 - (b) Analytical.
 - (c) Inorganic and Physical (including Radio-activity, &c.).
 - (d) Mineral and Metallurgical.
 - (e) Biochemistry.
 - (f) Organic Chemistry:
 - (i) General.
 - (ii) Technical.
- V. *Special Literature of Dye Chemistry.*

I. GENERAL DICTIONARIES AND ENCYCLO-PAEDIAS¹

O. Dammer, *Handbuch der Chemischen Technologie*. (5 vols. 1898.) Rather out of date, but gives useful information on various points where there have not been too great changes since 1898.

¹ It should be noted that this subsection does not include specialized works of reference on such subjects as organic, inorganic, or analytical chemistry, &c., which are dealt with under the corresponding headings (*vide infra*).

O. Dammer, *Chemische Technologie der Neuzeit*. (3 vols. 1911.) Fairly modern but somewhat too compressed save as a general outline.

Fehling (and others), *Neues Handwörterbuch der Chemie*. 1871-1913, still appearing in parts.

The articles are very full and have complete lists of references. If attention be paid to the date of any particular volume, the articles afford a fairly complete list of references to work on the subject concerned up to that date.

T. E. Thorpe, *A Dictionary of Applied Chemistry*. 7 vols. A new edition is being published, of which 5 volumes have been issued (1921-1924).

This covers a wide field, and in consequence the articles are mostly short summaries, and serve as introductions to the special works on the items discussed. Some of them are practically small monographs, and useful lists of references to the original literature are given. An index is to be included in the final volume.

F. Ullmann, *Enzyklopaedie der Technischen Chemie*. (12 vols. 1914-23.)

This is the most up-to-date work on technical chemistry yet published. The articles are written by experts and the illustrations and diagrams are excellent. In addition to the German patent references, there is usually a bibliography at the end of each article of great value for following up a subject.

W. Watts, *A Dictionary of Chemistry*. (4 vols. 1911-14.)

Wurtz, *Dictionnaire de Chimie pure et appliquée*. (7 vols. 1892-1908.)

The following reference books may be noted for use in connexion with actual laboratory work:

Chemiker-Kalender. (2 vols. published annually.) They contain a large amount of information useful in the laboratory; in particular the lists of organic and inorganic substances, their melting and boiling points and solubilities, are extremely valuable.

- The Chemist's Year-Book*, edited by F. W. Atack (2 vols. annually), contains very similar information in English and a useful chronological list of the more important journals with the years and volume numbers.
- Van Nostrand's *Chemical Annual* is somewhat similar in scope to the foregoing work and is in one volume.
- G. W. C. Kaye and T. H. Laby. *Tables of Physical and Chemical Constants*. (1921.) A short work (161 pp.) somewhat on the lines of Landolt & Börnstein's *tabellen*, giving a number of physical properties likely to be of value in the laboratory.
- Landolt and Börnstein's *Physikalisch - Chemische Tabellen* (2 vols. 1923, edited by Roth and Scheel) contain a great deal of classified information on the physical properties of chemical substances, with references to the original papers from which the measurements are taken. An important book.
- A. Seidell's *Solubilities of Inorganic and Organic Substances* (1916), as its title indicates, deals only with the solubilities of various substances.
- Tables annuelles internationales de Constantes et Données numériques*. Published since 1912. (vol. i for 1910, vol. ii for 1911, vol. iii for 1912, vol. iv for 1913-16). The volumes contain lists of all the latest physical and physico-chemical constants, such as absorption spectra, solubilities, &c.

II. CHEMICAL JOURNALS AND PERIODICALS

We have now to consider the journals in which original papers appear. In the first place we have what we may call shortly 'National' journals which are published in practically all modern civilized countries by national chemical societies. Of these we may note :

- American : *Journal of the American Chemical Society* (first issued in 1876), with which is incorporated (since 1913) the *American Chemical Journal*.

Belgian: *Bulletin de la Société chimique de Belgique* (since 1887).

British: *Journal of the Chemical Society of London*. (Published since 1847.) From 1841 to 1847 were issued the *Memoirs of the Chemical Society*.

Dutch: *Recueil des Travaux chimiques des Pays-Bas* (since 1882).

French: *Bulletin de la Société chimique de France* (since 1859).

German: *Berichte der Deutschen Chemischen Gesellschaft* (since 1868).

Italian: *Gazzetta Chimica Italiana* (since 1871).

Russian: *Journal of the Russian Physical Chemical Society* (since 1869).

Spanish: *Anales de la Sociedad Española Física y Química* (since 1903).

Swiss: *Helvetica Chimica Acta* (since 1918).

These are the premier chemical journals of their respective countries, and most of the important new work appears in one or other of them.

Besides these, however, a large number of more or less highly specialized journals have sprung into existence, particularly in Germany, of which the following may be noted:

Annales de Chimie et de Physique. This is the oldest chemical journal in existence, having been issued from 1790 to 1815 as the *Annales de Chimie*. In 1816 the title was amended as above, but in 1914 it was split up into the *Annales de Chimie* (ninth series) and the *Annales de Physique* (ninth series). It usually contains the most complete French original papers.

Giornale di Chimica Industriale ed Applicata. Published since 1919, deals chiefly with applied chemistry.

Die Chemische Industrie. Deals chiefly with chemical industry in Germany. It is now part of the *Zeitschrift für angewandte Chemie*.

Die Chemiker-Zeitung. Deals largely with the commercial side of chemistry.

The Chemical Trade Journal. Contains summaries of work and technical articles on special subjects, but is chiefly a trade paper; as also is

The Chemical Age (since 1918), similar to the above journal.

Chimie et Industrie (since 1918) is similar to our own *J. Soc. Chem. Industry*.

Comptes rendus hebdomadaires des Séances de l'Académie des Sciences (since 1776), usually referred to as the *Comptes rendus*, is comparable to our own *Transactions of the Royal Society*; but papers given in it are usually very abbreviated and lacking in experimental details.

Journal de Pharmacie et de Chimie.

Journal für Praktische Chemie (since 1834). Contains original papers, and does not differ very substantially from, for example, *Berichte, Annalen, &c.*

Journal of Industrial and Engineering Chemistry, now simply *Industrial and Engineering Chemistry*, published since 1909. It occupies an important place in chemical literature. It consists largely of original articles, often of considerable merit, dealing with special technical problems.

Chemical and Metallurgical Engineering. Deals very much with the purely technical side of chemistry, but sometimes gives useful summaries of technical progress in certain subjects.

Journal of the Society of Chemical Industry (since 1882). Until 1918 it contained relatively few original articles, but occasionally important lectures on special technical subjects appeared in it. Since 1918 it has been reorganized and is now divided into three sections: (1) a section which, since 1923, has been also issued separately as *Chemistry and Industry*, giving news on chemistry and chemical industry, correspondence and interesting articles upon scientific problems of current interest; (2) *Transactions* in which original contribu-

tions appear; and (3) *Abstracts* which deal more particularly with applied chemistry, and especially with British and foreign patents. The annual index is very ample and well arranged. It gives also a useful list of the price, &c., of the more important journals.

Liebig's Annalen der Chemie und Pharmacie (since 1832). This is one of the oldest purely chemical journals in existence, having been founded by Baron v. Liebig in 1832. A large number of valuable papers have appeared in it, bearing on important lines of research, but now exclusively upon organic chemistry. The articles are often very comprehensive and contain valuable historical summaries of previous work.

Monatshefte für Chemie und verwandte Teile anderer Wissenschaften (since 1880). This is published in Vienna and contains much of the work of Austrian chemists. It is also published in the first instance (with different pagination) as the chemistry section of the *Sitzungsberichte der kaiserlichen Akademie der Wissenschaft in Wien*, corresponding somewhat to our *Transactions of the Royal Society*.

Transactions of the Royal Society (since 1665). These Transactions deal with all branches of science. A certain number of highly important papers on chemical topics have appeared in their pages. The Royal Society aims at publishing the finished products of completed researches, as distinct from the short notes in the *Comptes rendus*.

Zeitschrift für angewandte Chemie (since 1888). The official organ of the 'Verein deutscher Chemiker'. It appears in three parts: (1) General, (2) Abstracts, and (3) Commercial. The Commercial part is now identical with *Die Chemische Industrie* (*vide supra*). The journal deals chiefly with matters of a technical nature.

Zeitschrift für anorganische Chemie (since 1892). As its name implies, it deals chiefly with papers on inorganic chemistry and contains many important original contributions on this subject.

Zeitschrift für Elektrochemie (since 1894). Deals with

electrochemistry chiefly, but also contains accounts of work on other branches of physical chemistry, and translations of similar articles from foreign journals.

Zeitschrift für Krystallographie und Mineralogie (since 1877). Deals with crystallographical and mineralogical researches, and contains crystallographic details of a vast number of compounds.

Zeitschrift für physikalische Chemie (since 1887). This contains papers on physico-chemical researches.

NOTE.—A useful list of all the more important chemical and technical journals is given in each annual index of the *Journ. Soc. Chem. Ind.* and also in the 1922 index volume of *Chemical Abstracts*. *Beilstein* (see p. 23), vol. i, also gives on pp. xxvi-xxix a valuable chronological table, showing the corresponding years and volumes of various journals, which is often of use for finding the year of publication when only the volume number is known. A similar list appears in Atack's *Year-Book* (*vide supra*).

III. ABSTRACT JOURNALS

The literature so far discussed has been of a general character and covers the whole field of chemistry.

Owing to the great bulk of the subject and the impossibility of reading all the new papers which appear, various abstract journals are published for the benefit of chemists, of which the following five may be noted :

- (1) *Abstracts of the Chemical Society*, published monthly in two parts, since 1849.
- (2) *Abstracts of the Journal of the Society of Chemical Industry*, published weekly (since 1882). Confined chiefly to papers likely to be of technical importance, especially to patent abstracts.
- (3) *Chemisches Centralblatt* (5th series, from 1897). This was first issued from 1830 to 1850 as the *Pharmaceutisches Centralblatt*, which became in 1850 the *Chemisches und Pharmaceutisches Centralblatt* until 1856, when it became the *Chemisches Centralblatt*. The publication was taken over by the German Chemical Society in 1897. It is issued weekly.

- (4) *Chemical Abstracts* (1907). Published by the American Chemical Society and now issued fortnightly. (From 1895 to 1906 its predecessor was issued as the *Review of American Chemical Research*.)
- (5) *Patent Office Official Abridgements* (1855).
 - Class 1. Inorganic (groups i, ii, and iii).
 - Class 2. Organic (groups i, ii, and iii). New sections are issued from time to time as they are completed.

While No. (2) *Journal of the Society of Chemical Industry* deals chiefly with technical papers, Nos. (1), (3), and (4) cover the developments of the entire field of Chemistry. Of the three, the Chemical Society's Abstracts are perhaps the least satisfactory ; for, although the actual abstracts are excellent, only a limited number of journals are dealt with, there is a lack of adequate subdivision, and the abstracts only appear monthly. Decennial Indexes are published, the last complete one being for 1903-12. The subject Index for 1913-22 is at present in the press. The 'author' Index has been issued.

The Abstracts of the Chemical Society and of the Society of Chemical Industry are now supervised by a Bureau of Chemical Abstracts, and are issued as the Pure Chemistry and Applied Chemistry Sections, respectively, of chemical abstracts.

The *Chemisches Centralblatt*, appearing weekly, was, prior to the war, possibly the best abstract journal for chemists. Recently, however, the American Chemical Society have very greatly improved their abstracts, abstracting regularly over 1,000 journals, and constantly extending their field.

So far as it is possible to compare *Chemical Abstracts* with the *Chemisches Centralblatt*, the latter often abstracts a paper more fully with regard to experimental details,

whilst the former covers perhaps a wider field but often needs to be supplemented by reference to looking up the original article.

A decennial Index to *Chemical Abstracts* has been published covering the period 1907-17.

As already noted, all the abstract journals publish DECENNIAL or QUINQUENNIAL INDEXES at intervals, as well as the usual annual Indexes, so that the latter need only be used for the years subsequent to the appearance of the last decennial Index. The collective *Centralblatt* Indexes are quinquennial.

The American chemical abstracts are of special value when making a search as, since 1920, a very valuable FORMULA INDEX of substances has been issued each year.

As regards No. (5), Patent Office Abridgements, these are issued in five-yearly periods, and may be seen in most public reference libraries or purchased for a small sum. As the patents are arranged numerically, they are a trifle difficult for the beginner to tackle, but with a little practice, the use of the five-yearly Indexes, and of the recently published '50-Year Index' 1860-1910 [Classes 1 (i), (ii), (iii), and 2 (ii), and (iii)], it is merely a matter of patience to find the required chemical patent abridgement, after which the corresponding patent specifications can readily be consulted.

Attention may also be directed here to the valuable annual summaries issued by various societies such as

The Chemical Society's *Annual Reports on the Progress of Chemistry* (since 1904).

Annual Reports on Applied Chemistry of the Society of Chemical Industry (since 1917).

Jahrbuch der organischen Chemie, by Dr. J. Schmidt.

Jahresbericht der Chemie, started by Liebig and Kopp in 1847.

IV. TEXT-BOOKS, AND SPECIAL WORKS OF REFERENCE.

(a) HISTORICAL.

- E. F. Armstrong, *Chemistry in the Twentieth Century*, edited by E. F. Armstrong (1924). An account written by various authorities on the achievements and present-day state of knowledge in chemical science in connection with the chemical exhibits at the Wembley Exhibition.
- S. Arrhenius, *Theories of Chemistry*, edited by T. S. Price (1907), contains the substance of lectures given in America on the development of modern chemical theories.
- Chemical Society, *Memorial Lectures*. (2 vols. 1893-1900 (1901), 1901-1913 (1914).) Contains reprints of memorial lectures given before the Society by distinguished chemists.
- E. Cohen, *Jacobus Henricus van't Hoff, sein Leben und Wirken* (1912). A complete biography of one of the founders of modern physical chemistry.
- I. Freund, *The Study of Chemical Composition* (1904). An account of the methods and history of the subject.
- A. Ladenburg, *Lectures on the History of the Development of Chemistry since the time of Lavoisier*. Translated by L. Dobbin (1900). A very good short history.
- T. M. Lowry, *Historical Introduction to Chemistry* (1915). Medium length, clear, and well illustrated.
- E. von Meyer, *A History of Chemistry*, translated by G. McGowan (3rd ed., 1906). A standard readable work on the subject.
- M. M. Pattison Muir, *A History of Chemical Theories and Laws* (1907). Clear and well written.
- W. Ramsay, *Essays, Biographical and Chemical* (1908). Includes essays upon some of the earlier chemists.
- *Life and Letters of Joseph Black, M.D.* (1918) with.

- an introduction by F. G. Donnan dealing with the life-work of Sir W. Ramsay.
- T. E. Thorpe, *Sir Henry Enfield Roscoe* (1916). A biographical sketch showing his influence upon the development of modern chemistry.
- *Essays in Historical Chemistry* (1902). Contains short biographies of many chemists.
- *A History of Chemistry*. (2 vols., 1921). Short but complete.
- W. A. Tilden, *The Progress of Scientific Discovery in our own times, with biographical notices*. (2nd ed., 1913.) A semi-popular work.
- *Chemical Discovery and Invention in the Twentieth Century* (1916). A clear and well-illustrated book of the more popular kind.
- *Famous Chemists, the men and their work* (1921). A series of short biographies arranged to form a history of chemistry and chemical theories.
- V. Volhardt, *Justus von Liebig*. (2 vols., 1909.) A full and interesting account of the life and work of one of the founders of modern organic chemistry.

(b) ANALYTICAL.

- Allen, *Commercial Organic Analysis*, 1909-17 (8 vols. and Index vol.), is of special value for details regarding technical methods. It also gives much useful information about the various substances mentioned.
- H. T. Clarke, *A Handbook of Organic Analysis, qualitative and quantitative*. (3rd ed. 1920.) A small but useful introduction to the subject.
- A. Classen, *Quantitative Analysis by Electrolysis*, translated by W. T. Hall (1919). Gives a good account of the more important methods used.
- F. Clowes and J. B. Coleman, *Quantitative Chemical Analysis* (1919). A good general laboratory book.
- H. J. H. Fenton, *Notes on Qualitative Analysis* (1920). A well-known and concise introduction to the subject.

- T. W. Fresenius, *Introduction to Qualitative Chemical Analysis*, 17th ed. 1921, translated by C. A. Mitchell. Comprehensive and clear.
- G. Lunge, *Technical Methods of Chemical Analysis*. (6 vols.) A new edition is in preparation.
- F. P. Treadwell, *Analytical Chemistry*, translated from the 8th ed. by W. T. Hall (1916). Vol. i. Qualitative; vol. ii. Quantitative. These are widely used and give very reliable information. Vol. ii is a little less systematic than some other works.

(c) INORGANIC, PHYSICAL, AND GENERAL.

Of the larger works the following may be mentioned :

- R. Abegg & Auerbach, *Handbuch der anorganischen Chemie*. (7 vols. 1905-21), dealing with groups 1 to 7 of the Periodic System. The volume dealing with group 8 is not yet issued; this work is very complete and concise.
- Allmand and Ellingham, *The Principles of Applied Electrochemistry* (2nd ed., 1924). This deals chiefly with the practical applications, but includes the underlying theories.
- K. Arndt, *Handbuch der physikalisch-chemischen Technik für Forscher und Techniker* (1915). Includes the substance of a number of articles which have appeared in the *Zeitschrift für Chem. Apparatenkunde* and gives details of much special apparatus used in various German physico-chemical laboratories. A useful work for the laboratory.
- D. A. Clibbens, *The Principles of the Phase Theory* (1920). Deals with heterogeneous equilibria between salts and their aqueous solutions limited to condensed systems with only one liquid phase.
- O. Dammer, *Handbuch der anorganischen Chemie*. (5 vols., 1892-1903.) Also concise and complete up to 1903.
- A. Eucken, *Grundriss der physikalischen Chemie*. (2nd ed., 1924.) An up-to-date and clear text-book

- of the subject, requiring a certain amount of mathematical knowledge.
- Foerster, *Elektrochemie wässriger Lösungen*. (4th ed., 1923.) A good summary of the electrochemistry of aqueous solutions.
- H. Freundlich, *Kapillarchemie* (3rd ed., 1923). An important work dealing with colloid chemistry and related subjects in considerable detail.
- J. N. Friend (and others), *A Text-Book of Inorganic Chemistry*. (10 vols. (in parts) of which 6 have been published, 1914-21.) A concise and up-to-date work.
- Gmelin-Kraut, *Handbuch der anorganischen Chemie*. 7th ed. (12 vols. with appendices, 1907-14). This work has much the same functions for inorganic chemistry as Beilstein has for organic chemistry, whereas Abegg's *Handbuch* (v. s.) is more in the nature of a critical summary and is more generally useful, in the same way that Meyer and Jacobson's *Lehrbuch* is valuable for organic chemistry.
- von Groth, *Chemische Krystallographie*. (5 vols., 1919.) Deals solely with the crystallographic aspects of chemistry.
- K. Hoffmann, *Lexikon der anorganischen Chemie* (3 vols., 1912-16.) This is intended to be simply a reference dictionary of inorganic compounds on the lines of Richter's *Lexikon*. It is not, however, complete.
- K. Jellinek, *Lehrbuch der physikalischen Chemie*. (2 vols., 1914-15.) A further two volumes are promised.
- *Physikalische Chemie der homogenen und heterogenen Gasreaktionen* (1913).
- G. Lunge, *Sulphuric Acid and Alkali*. (3 vols. and supplement, 1914-17.) This is the most authoritative work on the subject. It is being re-issued in a revised form in seven or more volumes dealing with the subjects of Sulphuric, Nitric, and Hydrochloric Acids, Ammonia, Alkalies, Fixation of Nitrogen, &c.
- W. C. McC. Lewis, *A System of Physical Chemistry*. (3 vols., 1918-19.) Vol. i. Kinetic theory; vol. ii.

- Thermodynamics; vol. iii. Quantum theory. A useful work.
- J. W. Mellor, *A Comprehensive Treatise on Inorganic Chemistry*, to be issued in about 7 vols. Vols. i to v are published (1921-4). It is very readable, contains a remarkable wealth of references, and is the most complete and up-to-date work on general and inorganic chemistry in the English language.
- I. Mendeleeff, *Principles of Inorganic Chemistry*, translated by T. H. Pope. (2 vols., 1905.) A little out of date, but very clear and full of valuable suggestions.
- H. Moissan (and others), *Traité de chimie minérale*. (5 vols., 1904-6.) A useful work in French.
- E. Molinari, *Treatise on General and Industrial Chemistry* (translated from the Italian by T. H. Pope, 2 vols., 1920). A very readable work containing much valuable information.
- T. M. Lowry, *A Text-Book of Inorganic Chemistry* (1922). A good general text-book.
- W. Nernst, *Theoretical Chemistry* (1923), translated and revised by L. W. Codd. A very clear text-book of general chemistry from the standpoint of thermodynamics and physical chemistry.
- W. Ostwald, *Lehrbuch der allgemeinen Chemie*. (4 vols., 1906-11.)
- W. Ostwald and C. Drucker. *Handbuch der allgemeinen Chemie*. (5 vols., 1918-24.) A comprehensive work on the fundamental principles of general chemistry.
- W. Ostwald and R. Luther, *Hand- und Hilfsbuch zur Ausführung physiko-chemischer Messungen* (1902). A valuable book for the physico-chemical laboratory.
- J. R. Partington, *Chemical Thermodynamics* (1924). A short introduction to the subject.
- A. C. D. Rivett, *The Phase Rule* (1923). A good short introduction to the study of the phase rule and heterogeneous equilibria.
- W. Ramsay, *Monographs on Physical Chemistry*. These monographs by various distinguished authors deal with all the more important aspects of the subject,

- such as the Phase Rule, Electrochemistry, Thermochemistry, Stereochemistry, and so on.
- Roscoe and Schorlemmer, *A Treatise on Chemistry*. Vol. i. Non-metals; vol. ii. Metals. Recently revised, vol. i. having been republished in 1921 and vol. ii republished in two parts in 1923. Very readable and clear.
- O. Sackur, *A Text-book of Thermochemistry and Thermodynamics*, translated by G. E. Gibson (1917). A clear and concise text-book.
- R. Staehler (and others), *Arbeitsmethoden der anorganischen Chemie*. (4 vols., 1913 and on.) This work gives a useful summary of the various ways of dealing with laboratory problems.
- V. van't Hoff, *Lectures on Theoretical and Physical Chemistry*, translated by R. A. Lehfeldt (1900). Vol. i. Chemical dynamics; vol. ii. Chemical statics; vol. iii. Properties and constitution. Although published many years ago, this important work still remains one of the clearest and most stimulating books dealing with physical chemistry.

Atomic Structure, Radioactivity, &c.

The following works are representative of modern books on this important subject :

- E. de C. Andrade, *The Structure of the Atom* (1923). Deals with the subject from the physical side.
- F. W. Aston, *Isotopes*. (2nd ed., 1924.) A general description of the subject with special reference to the method of positive ray analysis.
- N. Bohr, *The Theory of Spectra and Atomic Constitution*, translated by A. D. Udden (1922). This gives a summary of Bohr's views in the form of three lectures.
- W. Bragg, *X-Rays and Crystal Structure* (1923).
- P. Ewald, *Kristalle und Röntgenstrahlen* (1923). A very good work on the whole subject.
- K. Fajans, *Radioactivity*, translated by T. S. Wheeler and W. G. King (1923). A discussion of the whole subject.

- I. Gratz, *Recent Developments in Atomic Theory*, translated by G. Barr (1923). A short introduction.
- G. von Hevesy and F. Paneth, *Radioaktivität* (1923). An excellent book dealing with the whole subject (English translation in the press).
- II. A. Kramer and H. Holst, *The Atom and the Bohr Theory of its Structure* (1923). A good introduction to the subject, with some very clear diagrams.
- G. N. Lewis, *Valence and the Structure of Atoms* (1923). A discussion of the whole problem, stress being laid upon the Lewis-Langmuir theory.
- S. Meyer and E. R. von Schweidler, *Radioaktivität* (1916, new edition in preparation). A valuable textbook dealing comprehensively with radioactivity from the chemical, physical, and geological standpoints.
- V. Perrin, *Atoms*, translated by D. I. L. Hammick. (2nd ed., 1920.) Contains a full account of Perrin's well-known researches.
- A. S. Russell, *The Chemistry of Radioactive Substances* (1923). A concise and up-to-date review of the whole situation.
- E. Rutherford, *Radioactive Substances and their Radiations* (1913).
- M. Siegbahn, *Spektroskopie der Röntgenstrahlen* (1923). A very authoritative work on the subject (English translation in the press).
- F. Soddy, *The Interpretation of Radium and the Structure of the Atom* (1920). A general non-mathematical discussion.
- A. Sommerfeld, *Atomic Structure and Spectral Lines*, translated by H. L. Brose (1923). A very important work on the subject requiring a good knowledge of mathematics, including Sommerfeld's theory of the structure of spectral lines.
- A. Stock, *The Structure of Atoms*, translated by S. Sugden (1923). A good non-mathematical introduction to the subject.

(d) MINERAL AND METALLURGICAL CHEMISTRY.

This is, of course, a big subject with a large literature of its own, and the following works are only given by way of example :

Fulton, *Principles of Metallurgy* (1910).

Hofmann, *General Metallurgy* (1913).

Roberts-Austen, *Introduction to the Study of Metallurgy* (1910).

Roberts-Austen, *Metallurgy of the Common Metals* (7th ed., 1923) ;

whilst such works as—

Desch, *Metallography* (3rd ed., 1922), and

Guerta, *Metallographie* (1913), deal with the general properties of metals.

There are also many journals devoted partly or exclusively to the subject, such as :

Journal of the American Institute of Mining and Metallurgical Engineers (since 1871).

Chemical and Metallurgical Engineering (since 1902).

Engineering and Mining Journal (since 1869).

Journal of the Institute of Metals (since 1909).

La Métallurgie (since 1868).

Stahl und Eisen (since 1881).

Transactions of the Faraday Society (since 1905).

Transactions of the American Electro-Chemical Society (since 1902).

There are also numerous treatises dealing with the production and treatment of individual metals, which will be found in any scientific library.

(e) BIOCHEMISTRY.

This subject is one of increasing importance, and the following list is merely introductory. The standard work is :

Abderhalden, *Biochemisches Handlexicon* (7 vols. + 3 supplementary vols., 1911–23) ; whilst work later than

1923 can be tracked down easily in the American *Chemical Abstracts*, which makes a speciality of this subject and gives full abstracts of all relevant papers, as also does the *Centralblatt für Biochemie*.

Other useful works are :

Abderhalden, *Handbuch der biologischen Arbeitsmethoden* (1910 and on).

Fraenkel, *Die Arzneimittelsynthese* (5th ed., 1921), gives a valuable account of the connexion between chemical structure and physiological action.

R. H. A. Plimmer, *Practical Organic and Biochemistry* (1915). A good introduction to the subject.

There is also a useful series of—

Monographs on Biochemistry, published by Longmans, which deal with special subdivisions of the subject.

(f) ORGANIC CHEMISTRY.

(i) General.

The best-known and most readable work on this subject is:

Meyer and Jacobson, *Lehrbuch der organischen Chemie*. (2 vols. in 5 parts, i. e. vol. i, pts. 1 and 2; vol. ii, pts. 1, 2, and 3, 1897–1920.)

This has been published in sections at various times since 1897. It is the most complete text-book on organic chemistry, and besides being very clear and readable, it contains a wealth of references; if attention be paid to the date of publication of any particular volume, most of the important work and references thereto will be found in a concise and readable form.

Beilstein, *Handbuch der organischen Chemie*. (4 vols., 4 supplementary vols., and index vol. 1893–1906.) (Now being republished in a revised form, 4th ed. since 1918; 6 vols. have now been issued to date (1924).)

This work, together with Richter's *Lexikon* mentioned below, is the stand-by of the organic chemist. It is

intended to contain full details regarding every known organic substance ever investigated; but owing to the fact that the volumes were published at various dates from 1893-1906, the information is often very out-of-date and must be supplemented by searches elsewhere.

The original work consists essentially of four volumes and four supplementary volumes corresponding to them (which bring the information somewhat more up to date) (1899-1903), together with an index volume (1906).

The third edition is at present out of print, and the new revised edition is now being published in consecutive volumes which will include all information available up to 1 January 1910. The first four volumes cover the whole of aliphatic chemistry, the fifth volume (1923) deals with the isocyclic hydrocarbons, and the sixth volume (1924) with phenols, &c.

An equally important work, but in a somewhat different category, is :

Richter, *Lexikon der Kohlenstoff-Verbindungen* (3rd ed. 4 vols., 1910-12).

This work bears much the same relation to Beilstein as, say, a dictionary to the *Encyclopaedia Britannica*. That is to say, it contains all the organic compounds known (up to 1910) arranged according to the number of carbon atoms in the molecule, i.e. C_1 , C_2 , C_3 , C_4 , ... C_n , with suitable subdivisions in each section according to the number of 'foreign' atoms. Thus CH_4 is classified as C_1I ; $C_6H_5NO_2$ comes under the heading of C_6III and so on. Under each substance (which is given its full 'official' systematic name) is given only the melting- and boiling-points, together with references to the scientific and technical literature, and in particular the pages in Beilstein (3rd ed.) and the supplementary volumes, where the compound is fully described. By this means any unknown organic compound can be quickly identified once it has been analysed and its

empirical formula established, and the literature connected therewith speedily found.

'Richter' takes one up to 1 January 1910. The endeavour is being made to keep the *Lexikon* and Beilstein up to date from 1910 onwards by the issue in two-yearly periods of supplementary volumes edited by R. Stelzner, as *Literatur-Register der organischen Chemie*, of which the first four volumes, for 1910-11, 1912-13, 1914-15, and 1916-18, have been published.

'Stelzner' differs somewhat from Richter in giving much fuller details regarding each substance, and also regarding the nature of the researches to which references are given, i. e. whether physical determinations, condensations with specific substances, special uses, and so on.

Further details regarding the use of Beilstein, Richter, and Stelzner will be given later in Section II.

Two other important works of great use in the Organic Research Laboratory are :

Lassar-Cohn, *Handbuch der Arbeitsmethoden der organischen Chemie* (2nd ed., 2 vols., 1923).

Houben-Weyl, *Die Methoden der organischen Chemie* (2nd ed., 4 vols. 1922-24).

Both these works are very valuable indeed when undertaking a new investigation, and the synoptic summaries of methods of reduction, oxidation, condensation, and so on, given in the two works, enable one to decide quickly on the most hopeful line of attack; and in many cases full details of satisfactory methods of preparation are given which save much time in looking up references.

Another useful preparative work (which also includes inorganic preparations) is

Vanino, *Handbuch der präparativen Chemie*. (2 vols., 1914.)

Yet another useful work which it is intended to issue in annual volumes is :

Organic Syntheses. An annual publication of satisfactory methods for the preparation of organic chemicals, edited by R. Adams, H. T. Clarke, J. B. Conant, and O. Kamm, vol. i, 1921, vol. ii, 1922, vol. iii, 1923. These volumes contain full and reliable details for the laboratory preparation of numerous organic chemicals, which have been carefully worked out and checked.

In addition there are well-known text-books on organic chemistry such as those of Richter, Schmidt, Bernthsen, Perkin and Kipping and many others.

Special mention may also be made of—

F. Henrich, *Theories of Organic Chemistry*, translated by T. B. Johnson and D. A. Hahn, 1923, which contains a valuable summary of modern views on various branches of organic chemistry.

(ii) *Technical.*

On the technical side of organic chemistry the literature, especially the German literature, is very voluminous, and no attempt can be made to refer to all the monographs and special works published. The following series of monographs may, however, be noted :

Monographs on Industrial Chemistry, edited by Sir T. E. Thorpe (London : Longmans, Green). Many of these volumes deal with applied organic chemistry, e. g., fats and oils, dyes, sugar, and so on.

Chemische Technologie in Einzeldarstellungen (Leipzig, O. Spamer).

Industrial Chemistry, edited by S. Rideal (London).

Ahrens' *Sammlung chemischer und chemisch-technischer Vorträge* (Leipzig).

It is of considerable importance to become familiar with the titles of the individual monographs in these series, as much time may often be saved thereby.

L. Otto, *L'Industrie des Parfums* (Paris, 1909).

S. Fraenkel, *Arzneimittel-Synthese* (Berlin, 1922). The standard work on synthetic medicinal products.

R. Herzog, *Handbuch der chemischen Technologie der organischen Verbindungen* (Heidelberg, 1912). This gives a clear and concise account of various branches of organic technology, with illustrations of the plant used, and so on.

Since, however, many of the great advances in applied organic chemistry have, in the past, come from Germany, and have been embodied in the form of patent specifications, the two chief works are the collected German Patents edited by Winther and Friedländer respectively.

Winther, *Patente der organischen Chemie 1877-1905*. (3 vols., 1908-10.)

Vol. i deals with German Patents concerning organic products devoid of dye character, such as drugs, dye-intermediates, perfumes, photographic developers, and so on. Vol. ii deals with colouring matters, and vol. iii containing the general index also includes much useful information regarding proprietary names of drugs and dyes, and tables showing (up to 1905) the corresponding numbers of various British and foreign Patents.

The Patents in vols. i and ii are only quoted shortly ; but usually one or more examples are given, and the critical summaries at the beginning of each section are very useful. The German Patents dealt with go as far as No. 167933 of Jan. 1905, but the Index of British Patents goes up to 1908.

P. Friedländer, *Fortschritte in der Teerfarbenfabrikation &c.* (13 vols., 1877-1921.)

This weighty series of volumes is, so to speak, the 'Bible' of the technical organic chemist, and is also of

the utmost value to the academic chemist, as many important discoveries have been, and are, patented though their commercial value is often far to seek. They contain the complete specifications of every German patent dealing with organic chemistry since the introduction of the German patent laws in 1877.

Each volume is divided up into sections much as in the case of Winther, dealing in turn with aliphatic and aromatic intermediates, the various classes of dyes and lakes, synthetic rubber, flavouring matters, perfumes, synthetic resins, and tanning materials, and so on. Each section contains a short introductory *résumé* of the most important developments shown in the patent literature during the period dealt with. Every patent of the slightest importance dealing with organic chemistry will be found in one volume or other of Friedländer. Each volume is fully indexed, and the patents are also indexed by numbers, the indexes of numbers being cumulative. The last patent dealt with is No. 358774.

A recent production of more limited value is :

Lange, *Die Zwischenprodukte der Teerfarbenfabrikation* (1920). This contains a short summary of the patented methods for making aromatic intermediates, arranged systematically, thus affording a quick means of reference to all German patents on these matters.

As already noted on p. 14, those interested in British patents on organic chemistry will find abstracts of the patents in

British Patent Abridgements (1856 and on), Class 2 (iii) (Acids, organic ; including Dyes) ; which can be purchased for a few shillings, though some experience is required in carrying out a search.

In addition to the above books, various other special works are published on dyes, drugs, explosives, celluloid, artificial

silk, sugar, rubber, and so on; and, of course, valuable articles are contained in the various dictionaries already quoted.

V. THE LITERATURE OF DYE CHEMISTRY.

Owing to the special importance of this subject at the present day and the close connexion between the chemistry of dyes and the development of general organic chemistry, it will be worth while devoting a special section to it.

First, as regards general literature we have the usual quintette of *Beilstein*, *Richter*, *Stelzner*, *Winther*, and *Friedländer*.

An examination of these should give practically all the information required in so far as it is available.

Details regarding all important commercial dyes and lakes will be found in the—

Colour Index (1923). Published by the Society of Dyers and Colourists, which gives a full account under each dye of the constitution, preparation, properties, and literature references. A similar work is the German *Farbstofftabellen* of Schultz and Julius (6th ed., 1922, 2 vols.).

Another similar work, which however is now somewhat out of date, is the—

Systematic Survey of the Organic Colouring Matters (1918), by A. G. Green, and a fair amount of general information is contained in *Artificial Dyestuffs used in the United States, 1913-14*, by T. H. Norton (U. S. Dept. of Commerce Special Agents' Series, No. 121, 1915), though this volume, based upon Schultz and Julius's *Farbstofftabellen*, deals chiefly with the commercial side. It also contains (pp. 34-37) a very useful list of the more important works on colour chemistry.

Another useful work is—

O. Lange, *Die Zwischenprodukte der Teerfarb-fabrikation* (1920), already referred to.

Of other general works on the chemistry of the synthetic colouring matters we may note—

G. Schultz, *Chemie des Steinkohlenteers* (2 vols. 1901).

G. Lunge, *Coal Tar and Ammonia* (1916).

T. L. Bucherer, *Lehrbuch der Farbenchemie* (2nd ed., 1918), which is a readable and useful work, but has the disadvantage that it gives no references to the literature.

Georgievics and Grandmougin, *Text-book of Dye Chemistry*, translated and revised by F. A. Mason (1920). This also includes a revised list of the more important books on dye chemistry (based on Norton's list), and numerous patent and literature references.

Amongst other useful works may be noted—

Cain and Thorpe, *Chemistry of Dyestuffs* (6th ed., 1923).
An introduction to the subject.

J. C. Cain, *The Manufacture of Intermediate Products for Dyes* (2nd ed., 1923). This summarizes the available technical information regarding the methods of preparation of many of the important intermediates.

R. N. Shreve, *Dyestuffs Classified by Intermediates* (1922). The scope of this work is sufficiently indicated by its title.

H. Fierz-David, *The Fundamental Operations of Dye Chemistry* (translated by F. A. Mason, 1920). This contains full experimental details for the preparation of various dyes and intermediates, and also contains a good deal of valuable general information.

O. Lange, *Die Schwefelfarbstoffe* (1911), deals with the preparation and properties of sulphur dyes.

H. Wichelhaus, *Sulfurieren ; Alkalischmelze* (1911).

G. Cohn, *Die Pyrazolfarbstoffe* (1910).

A. G. Perkin and A. E. Everest, *The Natural Organic Colouring Matters* (1918).

J. T. Hewitt, *Dyestuffs from Pyridine, Quinoline, Acridine, and Xanthene* (1922).

Thorpe and Ingold, *Vat Dyes* (1923).

The following deal with the analysis of dyes :

v. Formanek, *Untersuchung und Nachweis organischer Farbstoffe auf spektroskopischem Wege* (1913). Deals with the spectroscopic analysis of dyes.

A. G. Green, *The Analysis of Dyestuffs* (1915). Deals with the analysis and identification of dyes by chemical means.

Mention may be made of—

H. B. Meyer, *List of References on Dyestuffs* (Washington 1919);

whilst, of course, the Annual Reports of the Society of Chemical Industry on Applied Chemistry are of great value in reviewing the situation.

The chief journals dealing with dyes are :

The Journal of the Society of Dyers and Colourists,
Färberzeitung,
Zeitschrift für Farbenchemie,
Revue générale des matières colorantes,
Colour Trade Journal.

Before completing this section we may note that the British Patent Office issues a very useful

Subject List of Works on Chemistry in the Library of the Patent Office,

which will frequently enable the student to find what books have been published upon the special branches of Chemistry he is interested in ; whilst those seeking a complete summary of the literature of Chemistry may be referred to

The International Catalogue of Scientific Literature,
Section D. (Chemistry),

which is a general subject and author index of chemical publications ; the last annual issue appeared in 1915, bringing the catalogue up to date to September 1913. The catalogue does not, however, include patent literature, which is rather a serious omission from the organic chemist's point of view.

Lastly, the

Catalogue of British Scientific and Technical Books, published in 1921 by the British Science Guild, is a useful guide to many works on special branches of chemistry.

We have now completed our survey of the more important works on Chemistry, and must turn to our second task, the actual literature search ; but before doing so a word of advice to the reader may be permitted. Do not rest content with a mere glance at the list of titles in this section. Go to your nearest Science Library and take a look at as many of the books as you can find, particularly the periodicals and monographs, and so become familiar with the general arrangement of the contents and the type of subjects dealt with.

A few hours spent in this way will be repaid later on many times over by the saving of time and labour due to 'knowing the literature'.

PART II

Making a Literature Search

Now that we have made a general survey of the situation and have become familiar with the available literature, we have to consider how best we can utilize it for assisting us in our chemical studies.

This section will be divided up as follows :

(1) *Organic Chemistry.*

(a) Looking up the properties and methods of preparation of a substance of *known* constitution.

(b) Identifying a substance of known empirical formula but of *unknown* constitution.

(c) Making a literature search on a technical problem.

(2) *Inorganic Chemistry.*(3) *Physical Chemistry.*

I. ORGANIC CHEMISTRY.

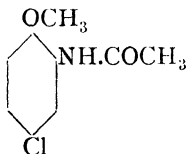
We start with this branch, because whilst on the one hand it is the most complicated and involved branch of chemistry, on the other hand it is extremely fully documented, arranged and indexed, so that the experience gained in dealing with organic chemistry will, *mutatis mutandis*, assist also in searching for information in other branches.

(a) *Looking up the properties and methods of preparation of a substance of known constitution.*

This is, perhaps, the chief type of search which a chemist requires to make; either he may wish to prepare some

compound for further investigation or comparison, or he may wish to ascertain whether a certain substance, or type of substance, has ever been made before.

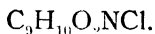
Let us suppose, therefore, that we wish to find out if a substance of the formula :



has been made before and, if so, its mode of production and properties. Structurally it is an *ortho*-acetylamino-*para*-chloroanisole, or alternatively, it is the methyl ether of 2-acetylamino-4-chlorophenol.

In view of the fact that most organic compounds may be described in several different ways, the number of possible alternatives increasing with the increase in complexity of the molecule, it is always advisable to look up the substance in the first place in Richter's 'Lexicon': thus the present substance may also be described as *Methyläther des 4-Chloro-2-Acetylamido-1-Oxybenzol*, or *Essigsäure-[methoxy-2-chlor-4-anilid]*.

In the present case the empirical formula will be



We therefore look at Richter and turn to vol. ii ($\text{C}_9\text{H}_{11}\text{O}_3\text{Br}_3$ to $\text{C}_{13}\text{H}_{10}\text{ON}_2\text{Br}_2$). As there are four elements besides carbon we turn to the pages marked '9IV' and on p. 1370 we find a list of substances of the formula $\text{C}_9\text{H}_{10}\text{O}_2\text{NCl}$, and under No. 4 we find the following entry :

No. 4 Methyläther d. 4-Chlor-2-Acetylamido-1-Oxybenzol. Sm. 104°. (*B.* 32. 2623 ; D.R.P. 137956. *C.* 1903 (1). 113).—*II. 416.

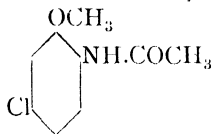
This indicates the following facts: melting-point 104° ; a reference to a paper in the *Berichte der Deutschen Chemischen Gesellschaft*, vol. xxxii, p. 2623; also to a German Patent No. 137956 (*v. i.*), an abstract of which appears in the *Chemisches Centralblatt* for 1903 (1), p. 113; lastly, details regarding the substance may be found in Beilstein's *Handbuch der organischen Chemie*, 3rd ed., vol. ii, supplementary volume p. 416 (the asterisk indicating the supplementary volume), where we find only a reference to Ber. xxxii. p. 2623.

Now, as to the patent; we turn to the last volume of Friedländer's *Fortschritte* and look up the numerical index at the end, where we find the entry:

137956. Dez. 08. VI. 1299.

Turning to vol. vi, p. 1299, we find in D.R.P. 137956 details of a process, patented by the Aktien-Gesellschaft für Anilinfabrikation in Berlin, for the preparation of 2-amino-4-chloro-5-nitrophenol methyl ether *via* the 2-amino-4-chlorophenol methyl ether, and the formation of the acetyl-amino compound m.p. 104° .

We have now obtained the available information up to 1st January 1910, and turn to Stelzner's *Literatur-Register* for 1910-11, 1912-13, 1914-15, and 1916-18, again looking up our compound under the 'C₉ IV' heading. The only reference in the 1910-11 volume is to the isomer Essigsäure-[methoxy-2-chlor-4-anilid]:



The 1912-13 volume has no reference to it, whilst the 1914-15 volume only refers to the above isomer, and the 1916-18 volume does not refer to either substance.

We now arrive at a tedious part of our task ; owing to the disorganization wrought by the war, the issues of ' Stelzner ' have been delayed, so that for the period 1st January 1919 to 1st January 1920 it is necessary to look up either the separate Indexes of the *Chemisches Centralblatt* (there are two Indexes a year), of the American *Chemical Abstracts*, or of the Chemical Society's *Abstracts* (the latter, however, owing to their incompleteness, are less reliable for making a search).

There is a Decennial Index 1907-1917 for the American *Chemical Abstracts*. A Decennial Index 1913-22 for the Chemical Society's *Abstracts* is in the press; the index of authors has been published.

Both names, Methyl ether of 2-Acetylamino-4-chlorophenol and Amino-*p*-chloro-anisol (acetyl) as well as Methoxy-chloro-acetanilide should be looked up in the Indexes. Actually we find no references to our substance for this period.

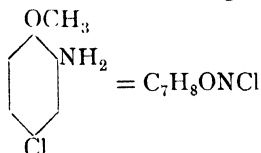
We now turn, from 1920 and on, to the Annual Formula Index of the American *Chemical Abstracts*. Here also we find no references, so we may assume, therefore, that the only available information up to 1st January 1924 is that already quoted in Richter, and can feel reasonably satisfied that we are not likely to have overlooked anything important.

For the current year the only thing to do is to look up the half-yearly *Centralblatt* Index and then, if desirable, continue the search with the later separate numbers of the Abstract journals.

The fact should be remembered, when making a search, that an Index will only tell us just what we look for, and some common sense should be brought into play.

In the present case, for instance, it is obvious that the

acetyl compound can be obtained without difficulty from the corresponding amine ; so that, in addition to looking up $C_9H_{10}O_2NCl$, we should also look up the free base :



to see if there are any further references under this heading.

In a similar manner if a methyl ester can not be found, then the ethyl ester or the free organic acid may be looked for, and so on.

(b) *Identifying a substance of known empirical formula but of unknown constitution.*

The general procedure is the same in this case as in (a) except that for the year 1919 there is no simple means of searching for a substance by its formula alone. If a reasonable guess can be made at the probable constitution, the substance may be looked up in a subject-index for this year.

(c) *Making a literature search on a technical problem.*

A search should be made in the usual way with Richter, Beilstein, Stelzner, and Chemical Abstracts ; but the subject should be looked up as well in Winther and Friedländer.

Thus if one is interested, say, in Vanillin, on looking at the Index Volume of Winther references will be found to pages 467, 470, &c., in vol. i, in which abstracts of the patented processes are given, together with a general discussion of the methods used. The full patent specifications should also be examined in Friedländer's *Fortschritte*, volume by volume, together with Friedländer's comments on the probable usefulness of the methods quoted.

When this has been done, references to cognate matters should be looked up in the same way, such as Aldehydes, Methylation, &c.; and the pages of Lassar-Cohn's *Arbeitsmethoden* and Houben-Weyl's *Arbeitsmethoden* on the same subject should be consulted.

Further, the articles in Thorpe's *Dictionary of Applied Chemistry* or in Ullmann's *Enzyklopaedie* should be read through, and a book should be looked for dealing with the subject; in the present case Otto's *L'Industrie des Parfums*, though a little out of date, affords much useful information.

To take a different case, let us suppose we wish to examine the production of a colouring matter, say Congo Red. On looking this up in the *Colour Index* we find under No. 370 that it is formed from benzidine, diazotized and coupled with naphthionic acid. In the fourth column are references to the patents, together with a list of references to original papers in the *Berichte*, and so on.

If it is desired to examine the methods for the production of benzidine and naphthionic acid, or any other 'intermediates', we look up the substance in 'Richter' in the usual way for information up to 1910, whilst Lange's *Zwischenprodukte der Teerfarbenindustrie* covers the ground as well, so far as concerns *patented* processes up to 1920. Again, Cain's *Manufacture of Intermediate Products for Dyes* will provide further information. In this way we shall be able to ascertain all available information on the dye intermediates, using the American *Chemical Abstracts* annual Formula Index to bring the subject right up to date.

In the literature of the dye industry there are a number of monographs dealing with special classes of bodies, such as Cohn's *Carbazol* and his *Pyrazolonfarbstoffe*, Hewitt's

Dyes derived from Acridine, Pyridine and Quinoline, and others in Longman's 'Monographs on Industrial Chemistry' and so on, which are very helpful when investigating such special groups.

II. INORGANIC.

In dealing with literature searches on problems connected with Inorganic Chemistry the procedure will be much the same as before, except that we have no Richter or Beilstein to help us.

Generally speaking, it will be best to look up any given subject in one of the most recent text-books of Inorganic Chemistry, such as Mellor's *Treatise on Inorganic and General Chemistry*, which is very fully documented, or the *Handbuch* of Abegg or Gmelin-Kraut, noting carefully the date of publication. Information regarding later years is obtained, of course, in the usual way from the annual and decennial Indexes of one or other of the Abstract Journals.

As always, common sense should be used when searching the Indexes; thus when seeking information, say upon the rusting of iron, the following entries should be tried:—

Rust.

Iron.

Steel.

Corrosion.

Metals, corrosion of.

Oxidation, &c.

In this way sufficient references will be obtained, and from these papers other cross-references will almost certainly be forthcoming.

Attention should also be paid to the possibility of there being monographs on special departments of Inorganic Chemistry, which will save much time and labour.

III. *Physico-Chemical.*

Similar considerations apply here as under Section II (Inorganic). In many cases, e. g. electrical conductivities, this may involve a search both of Organic Chemical Literature for the properties and methods of preparation of some special acids, or works on Inorganic Chemistry, and of such physico-chemical works of reference as Landolt Börnstein's *Physikalisch-chemische Tabellen*; whilst special works such as Findlay's *Phase Rule* or Clibbens's work on the same subject, Thomson's *Thermochemistry*, and so on, will give valuable assistance up to a point. Works such as Nernst's *Theoretical Chemistry* or Mellor's *Treatise* may afford useful clues.

There is no hard and fast rule in such cases, and the completeness of a search will often depend upon the skill of the chemist in thinking out likely headings in the indexes, and sometimes, it must be admitted, upon the element of luck. Usually, however, when one or two papers have been found connected with a subject, a good many fresh references will be found in them and so on.

GENERAL.

To sum up, do not start a long piece of investigation until you are reasonably sure you have made a thorough search of the literature; if you look things up in a text-book, note the date of publication and refer to annual or decennial Abstract Indexes for later information.

It will usually be best to make a list of references first, before looking up the actual papers. This is possibly a

matter of psychology rather than chemistry, but unless some such plan is adopted one is likely to overlook papers. Then when it comes to abstracting information it is a good idea to have separate slips of paper for each abstract headed like this—

| | |
|-------------|------------|
| Subject : | Author : |
| Reference : | Abstract : |
| | |

and these abstracts can later be filed together, for further reference.

In the Appendix will be found a Chronological Table showing at a glance the periods covered by the various Indexes to Abstract Journals, works of reference, and so on, which will assist in making clear the method of literature searching which has been recommended.

Chronological Table

showing

INDEX DATES OF CHEMICAL PERIODICALS AND REFERENCE BOOKS

| To December:— | 1870 | 1880 | 1890 | 1900 | 1910 | 1920 | |
|---|-----------------|---------------------|-------------------|-----------------|-----------------|------------------------------|--|
| | '72 '74 '76 '78 | '82 '84 '86 '88 | '92 '94 '96 '98 | '02 '04 '06 '08 | '12 '14 '16 '18 | '22 '24 | |
| Journal Chemical Society <i>Decennial Indexes</i> | 1841—1872 | 1873—1882 | 1883—1892 | 1893—1902 | 1903—1912 | 1913—1922 | |
| Chemisches Centralblatt <i>Quinquennial Indexes</i> | 1870—1881 | | 1897—1901 | 1902—1906 | 1907—'11 | 1912—1916 | |
| American Chemical Abstracts <i>Decennial Index</i> | | | | | 1907—1916 | 1920 1921 1922 1923 | <i>Annual Formula Indexes</i> |
| | | | | | | | |
| Beilstein: "Handbuch" Vol. 1----- | | (M) to 1893 | (S) 1893—1899 | | | | |
| 2----- | | (M) to 1896 | (S) to 1900 | | | | |
| (Main Volumes = M) | | (M) to 1897 | (S) to 1903 | | | | |
| Supplementary Volumes—S) 4----- | | (M) to 1899 | (S) to 1903 | | | | |
| Beilstein: "Handbuch" (New Edition) (Vols 1—6 published)----- | | | to 1909 | | | | |
| Richter: "Lexikon" ----- | | | to 1909 | | | | |
| Stelzner: "Literatur register" | | | | | 1910 —'11 | 1912 —'13 | 1914 —'15 |
| | | | | | | 1916 —1920 | |
| Winther: "Patente" | | | 1877—1905 | | | | |
| Friedländer: "Patente" | | Vol. 1 1877—1887 | 2 1890 to 1894 | 3 to 1897 | 4 to 1900 | 5 1902 to 1904 | 6 1907 |
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